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ABSTRACT

This paper suggests means of merging educational ideas with new information and communication technologies to aid individuals with disabilities. New technologies discussed include microtechnology and integrated circuits, high speed processing and retrieval of information, and light-weight equipment, among others. New technologies can be used as aids in mobility, communication, diagnosis, training, information processing, expressive and creative activities, and recreational activities. The role of new technologies (television, the modern car, etc.) as potential "disablers" for individuals with certain disabilities is also described, and ergonomical considerations such as display resolution and keyboard complications are examined. Technologies and equipment are then surveyed, such as radio and television, film and videotapes, electronic mail, voice recognition, touch screens, artificial intelligence, word processing, image processing, interactive video, digitalized and synthetic speech, and tactile displays. Impacts of new technologies on interpersonal communication, language acquisition, creativity, and other factors are noted. The question of equity and autonomy for all members of society is explored. Requirements for integrating disabled students within ordinary educational institutions are spelled out, focusing on the areas of: information collection and dissemination; adapted educational and social infrastructure; availability of suitable hardware and software; resource allocation and administration; physical and social integration; and ethical considerations. Implications of new technologies for teacher education are described. (JDD)

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THE QUANTUM LEAP IN SPECIAL EDUCATION

New Information and Communication Technologies Their Impact upon Educational Opportunities for Disabled People, focussing on how Integration in the Ordinary Educational System can be facilitated

by

Rolf Kristiansen

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THE QUANTUM LEAP IN SPECIAL EDUCATION AND REHABILITATION ?

NEW INFORMATION AND COMMUNICATION TECHNOLOGIES - THEIR IMPACT UPON EDUCATIONAL OPPORTUNITIES FOR DISABLED PEOPLE, FOCUSSING ON HOW INTEGRATION IN THE ORDINARY EDUCATIONAL SYSTEM CAN BE FACILITATED.

1. TECHNOLOGY, DISABILITY AND EDUCATIONAL OPPORTUNITIES

1.1. An increasing openmindedness and flexibility in established educational systems and institutions concerning the use of new technologies

The last years of educational and technological development have given a new perspective to disabled people. The rapid development of technology, techniques and technological applications in special education and rehabilitation opened for a new era. On the one hand for the disabled themselves, - and on the other for people and institutions dedicated to realise ambitious aims on their behalf.

The concept of integration has prospered during the last 20 years, creating an intense discussion about a reorganising of educational systems, institutions and practice. Parallelled by new technologies, the scenario was set for rather dramatic changes for the parts involved.

An "educational revolution" did not occur, but for many of the co-workers new ideas, possibilities and plans emerged. One of the main results from this process has been the highlighting of why and how more institutionalised students could take part in daily life and education within their own local communities. For some, a reduction in the need for specialised institutions may have been the main motivation, whereas most of the attention from administrators and active field-workers refer to their concern for the disabled as an integrated member in school and society.

The emergence of new technologies in education is one of the best examples of how the educational situation can be changed for severely disabled students. Either if it is as a communication tool, a mobility aid, an apparatus to simplify learning or as an instrument to professionalise teachers, these newly developed

technologies open a new world of learning and living. Their impact upon integration activities and processes are well documented, and this paper has as one of its main purposes to suggest ways and means of merging educational ideas and new information and communication technologies.

1.2. A changing perspective - handicap or disability?

From sociolinguistics we know that language is used as a "labeller", giving certain attributes to ideas and objects depending upon context and words used. From our own field we are now experiencing the shift from HANDICAP to DISABILITY, explaining to us that the complete blocking of certain activities signalled by the word handicap may be obsolete. Disability signals that some functions are not serving a person in an appropriate way, but we also can understand that these problems in some way may be overcome.

This use of words gives a more positive perception of a "handicapped" person's opportunities in school and society. In the following, a few examples will be given to document this change of direction.

1.2.1. De-emphasising traditional handicap-classification according to medical diagnosis

The traditional classification of impairments and handicaps is strongly related to a medical or physical/descriptive attitude. The reasons are clear. To describe a certain condition, you have to rely upon a set of criteria for inclusion or exclusion in a category. This applied to medical treatment and economical support from the social service.

Even for educational purposes this was the main road to describe the student. For diagnosticians it was necessary to have this set of tools to classify the students according to "entrance criteria" in special schools and institutions. A loss of hearing within a certain range of frequencies or sound levels (dB-scale) could or could not qualify for special education treatment or the acquisition of equipment. Similarly scores on a test of intellectual abilities would decide placement in sc ool.

This way of classifying still have its right for some unquestionable purposes, but the one-dimensional approach may inhibit development more than inspire to growth.

1.2.2. Underlining functionality and ability to cope with a disabling environment

An alternative approach to the medically based classification is to apply a more holistic or multidimensional assessment of the

student. Here we have to compare impairments with well developed abilities, intellectual capacity and psychological variables like motivation, tolerance of frustration etc.

Additionally, we must never forget that disability is not an absolute concept - it is always compared with the environment and the tasks an individual is required to accomplish within that environment. We therefore have at least three ways of overcoming hindrances:

a) - to concentrate on the impairment as such, according to a diagnosis, using remedial methods like corrective surgery and medication, therapeutic techniques and training or use of prosthesises.

b) - to compensate for the impaired function by supporting other functions, either by training or by using adaptive equipment and technical aids.

c) - to "redefine" the environment and task requirements in such a way that the previously impaired functions no longer are required, or that the relative impairment no longer exists or has been reduced (e.g. stairs and wheel-chairs).

The last two approaches make necessary that the total life situation of the disabled is taken into account as part of the problem-solving. The preferred way of working should, however, be to combine all three approaches in a total evaluation of the disabled and hers or his situation. The main aim is to benefit from the individual's own resources, to increase functionality and prepare for a richer life as full member of the society, both as ordinary citizen and in the working life.

1.2.3. The disabled as integrated - not segregated member of society

For years disabled people have been in a segregated position in our societies. Not necessarily in a complete segregation, but in many situations to a very high degree. Partly because of organisational or institutional practice, but also as a function of social attitudes in the public. To some degree, attitudes among disabled people themselves may also be part of the explanation.

An increasing interest in disability and a growing concern for a community which can include all, has resulted in attitudes favourable to a more open society. Attitudes is on the other hand not enough to achieve ambitious aims. As previously stated, impairments must be mastered, and the disabled should find acceptable roles in society and be fairly honoured for their participation in working life.

1.2.4. The disabled as participant in the active working life

Disabled people are in some contexts described as invalid, e.g. of little value. Taken literally, this term implies that some type of cost-benefit analysis is applied. As we then use the term disabled, we are to some extent leaving the question of value related to cost. This perspective is based upon a pure economic and materialistic consideration, whereas participation in a civilised society also include many other variables, difficult to measure but of undisputable value to the individual and the total community.

If we look back in history, we will find that disabled people have been active within working life in a diversity of jobs. We must, however, admit that the social position of disabled in a work environment too often has been very low. When we today try to simplify the transition from school to active working life, we not only think of the "normal" students as laborers. Going farther we can find procedures and methods designed to give disabled people equal employment opportunities. Not only in sheltered workshops, but even more often in ordinary positions, were the work environment has been adapted for just this employee.

One of the main facilitators in these efforts have been the rapid development of new information and communication technologies. In historical perspective, never before have we seen so many new positions opened up for disabled people, thanks to spin-offs from technological developments in other fields, like astronautical research etc. We can with good reasons ask if this is in some way the quantum leap in special education.

1.3. The quantum leap in special education? New information technologies and a renewal of the educational process

The concept "quantum leap" is taken from modern physics. It describes the dramatic change in thinking from a Newtonian observable world to a Bohr world with very complicated relations between objects, and where variables like time and room has lost much of its significance.

In the same way, many of the established attitudes about impairments must be changed. We know excellent examples of how the new technologies has helped to overcome severe hindrances. We can meet people without the ability to speak in active conversation using a speech processor. Cerebral palsied children are using adapted keyboards to manage complicated tasks on a PC (personal computer), or they are using it for communication purposes. Even for severely impaired groups like the deaf-blind we can find answers to previously "impossible" questions.

For the educational process itself, we can see a shift in

teachers' roles from "the one and only authority" to a consultant helping each student to maximize learning from a diversity of sources. It can be film or video as well as computerised information. Distance teaching with the use of satellites and communication networks can give a totally new learning experience for all parts involved - students, teachers and administrators.

The QUANTUM LEAP may be an exaggeration, as related to its origin, modern physics. In special education and rehabilitation the term is both valid and adequate to describe the new and promising outlook for some groups which until now have been left behind, because of missing techniques and methods. We therefore welcome a new era of educational practice with information and communication technologies as a supplement to the existing professional work with disabled.

2. NEW INFORMATION AND COMMUNICATION TECHNOLOGIES AND THEIR POSSIBLE APPLICATIONS IN SPECIAL EDUCATION

2.1. New information and communication technologies (NICT)

Technological development often creates an impression of change and need for a redefining of realities. This has been very clear when studying the use of electronics and microelectronics in society and education. We can go back to the early days of film production and later to the use of sound tracks making this new medium a very powerful communicator. In the beginning this was a mechanical/optical invention - afterwards, with the transition to radio, TV, video and computer technologies, microelectronics has been in the focus. A few characteristics of this development will be described to give a picture of where we are - and where we are going.

2.1.1. Micro-technology and integrated circuits

These two concepts are closely connected with the development of new information and communication technologies. The essence of this connection is the availability of small-scale constructions, combining thousands of components on a chip with the size of a finger-nail. Researchers are now working with chips capable of holding more than one million elements.

The effect of this is that we not only have the enormous number of components. They are also interrelated, fitting the chip to execute tasks which we some years ago would have needed large equipment, often located in huge buildings to run. A computer is the most used example, but we can as well look into a camera, TV-set, radio, dish washer, calculator or drill and find these integrated circuits. They are the key to what the instrument or tool can achieve.

2.1.2. High-speed and high capacity of storage, processing and retrieval of information

For educational and special educational purposes, we are interested in these components and their potential use because of their enormous capacity of information storage, processing and retrieval. Combined with the high speed they can work with, they are excellent for communication purposes, especially when we are looking for systems that can handle complicated information, store it and distribute it in some way, either on screen, in print or as auditive output.

The typical case is when in storage and retrieval of information directly, without any processing of it. Video- and audiotapes are good examples. In education we also may ask for some processing of information. Computer-aided learning can store information and programs for later use, interacting with the student to a predefined level and process this "conversation" to give adequate feedback to the learner. Some systems may also give feedback to the teacher on how the student proceeds through his tasks.

Large scale or very large scale integrated circuits (LSI/VLSI) with high speed and capacity, make it possible to combine communication media (computer and film/sound/video) to constitute a new medium based on interaction. This can be linked together in networks or be full-functioning stand-alone work-stations. In distance education an idea of virtual schools, i.e. not physically existing schools but educational communities based on extensive electronic net-works, has emerged.

The development of computer architecture, from being an advanced calculator to a multitasking unit regulating 10-15 simultaneous and interrelated processes, opens a new perspective on how to meet the needs of disabled children, youth and adults.

2.1.3. Light-weight equipment

We cannot see directly how small the new components are, but we can feel it. The immediate effect for the user is that instruments which should have been heavy, nearly impossible to move or carry, now are in the extreme light-weight range. Twenty years ago a portable computer weighing 3-4 kg would have been a dream, especially when we take into account that it also has much higher capacity today. What it will look like after another twenty years, we may guess upon.

The main visible parts will presumably be keyboard and flat-screen, perhaps having voice input and/or output as an alternative to using keys and display, whereas the processor, controllers and memory options are integrated in the keyboard. The size and weight may equal a small book.

The effect on portability of equipment has immediate effect on

the usability among disabled. It can be carried as a communicator (synthetic speech) or brought around for learning purposes, notetaking or word processing.

2.1.4. Reliability and durability

The reliability, stability in function and durability of equipment based upon integrated circuits are well known facts. In addition it is also an easy task to service it, because a defect module can easily be replaced by a new one. This secures a more permanent use of technical aids, reducing time for service and repair to a minimum.

With formal or informal international standards in production, like cassette- and diskette-formats, the possibility for interchange between systems is also increased.

2.1.5. Price/performance development

Another aspect is the price/performance ratio. With the use of integrated circuits and light-weight equipment, production costs are lowered, service costs are shrinking and high-volume production shows up in reduced prices. This happens simultaneously with a tremendous increase in product performance. In a total evaluation the result is very positive for the potential user.

2.1.6. "Intellectual" complexity

An unintended effect of the micro-trend is that the user-interface between man and machine changes. Digital displays, keyboards and special operating routines may make some potential users anxious when using new equipment. This fear or anxiety is easily compensated for through benefits from use, but we have to take account of it as a potential problem in the planning stage of the implementation of new technology. Favourable attitudes among users and professionals are necessary requirements for technological development and change.

2.1.7. NICT goods as a commodity

New information and communication technologies is more or less treated as commodities in a consumer market. This tendency has been clear in several product groups. Calculators and watches are good examples, together with TV and video, cassette-recorders and players for compact discs. Here we have integrated circuits with high capacity, combined with laser-technology and high density storage of information. Similarly, computers are handled as a commodity in many countries.

The consumer commodities represent a market for technological development. Special education and rehabilitation is another "market" where new technologies are very important, and where spin-offs from other research and applications already are integrated in a very fruitful way.

2.2. Special education applications of NICT

2.2.1. Teaching and learning

From an educational point of view, teaching and learning has been seen as the focal point for use of NICT, and with good reason. If we pass through a list of teaching functions, we will see that in presentation of information, film and video techniques are excellent examples of use. In a special needs situation, we will also find that use of simplified information in pictogrammes and symbols can easily be transferred to a computerised approach.

When we see it from the learner's side, it immediately appears that the situation has been changed in a dramatic way when printed material was substituted by living pictures. Combined with video-techniques, opening a new world of interaction between sender and receiver, with information searching, organising and eventually behaviour modification, learning activities has got a new perspective.

2.2.2. Substitute for disabled function(s)

As previously mentioned, the term disability refers to functions not adequately developed, or blocked by injury or disease. Medication, corrective surgery and adaptive equipment are often used to overcome some hindrances. The use of glasses is perhaps one of the best known adaptations for people with low vision, whereas total blindness only in a few cases can be treated by surgery. Other physical disabilities like hearing loss or paralysis may be treated in a parallel way.

The use of prosthesis is not the main aim of this presentation, but it is necessary to use a few examples, just to show how NICT can be applied here. Going back to the blind, it should have been impossible to work with a text on a computer display, unless he was able to discriminate between different contrasts, which in turn could be enlarged on the screen. The use of tactile displays has changed this.

In principle it is possible to let every character on a 80*25 computer display be represented on a tactile braille-display. The cost incurred is high, so for most practical purposes it is a better solution to have any two of the 25 lines on the computer display represented. An alternative solution is to use a pointing device which reads the characters, words and sentences on the display, transforms them to speech and gives the person using it

an auditive feedback as it is moved across the display. In this way it is possible for a totally blind person to read a display of text, directly transferred to speech as an alternative to the visual impression. This use of synthetic speech gives a flexible instrument for browsing texts to find just the paragraph of interest.

Going a little into the future, as researchers are doing, we can as well think of a link directly to the nerve system, giving a visual impression interpreted in nearly the same way as in normal vision.

In another area the researchers are already using the same principle. Deaf people have received an "electronic transplant" giving an auditive impression more or less similar to what is normal hearing. It is not a usual hearing device like an amplifier. Instead it is transposing sound into electronic signals linked directly to the nerve system as a "repair set" to compensate for the disabled hearing function.

The technique of applying myo-electric control after amputations involves the use of an electric signal from the muscle to control a battery and motor connected to a prosthesis. This gives the opportunity to pick up impulses from the wrist flexors and extensors to open and close an electric hand. Such a prosthesis can as a rule be controlled without having to think of it.

2.2.3. Mobility aids

Mobility aids cover equipment which can be used to move a person from one place to another as well as devices applied for the blind to navigate in unknown areas.

The first group is well known, with wheel-chairs, adapted cars etc., and which can draw upon speech recognition, servo-systems to ease the daily use and communication systems to integrate some of these mobility aids in the home environment. The physically disabled have got new opportunities in employment, social life and education with some of these facilities, often based on robotics.

Many blind persons have a tremendous capacity to find their way in partly unknown areas, but unexplored fields always reveal some surprises. For some of the blind it has always been beyond their ability to navigate outside well-known surroundings. The problems are complex, since the navigation requires a cognitive map of the area to be dealt with, whereas the surprises like stairs, street posters, wires or furniture represent another type. To move without exposing oneself to immediate danger is difficult, and the use of a stick is today the most common aid.

An alternative solution may in the future be a set of ultrasonic devices, linked to a microprocessor. The ultrasound is emitted

from a transmitter with wide directivity to detect obstacles. The reflected ultrasounds are picked up like in echolocation with a two-channel receiver and transferred to the user binaurally through a stereo headset. Obstacles may in this way be perceived as localised sound images corresponding to size and location.

A device of this kind has proved to be effective in detecting tiny and/or sharp obstacles placed in front of the user. A similar device has been used to give a blind the opportunity to drive a motor bike in a controlled setting, an experience never thought of before.

2.2.4. Communication

The examples mentioned above are compensatory as related to disabled functions. They represent the one-way prosthesis, helping the input of information. We all need a two-way solution for communicative purposes, and for many disabled the compensation of malfunctioning channels is a prerequisite for efficient conversation.

A large group of disabled, many of them cerebral palsied, have been termed "without language", because they do not have a spoken language. This conception is wrong. They are often only lacking the ability to pronounce, write or give signals and use symbols to express themselves. Compensatory activities here could be the use of a speech synthesiser, a writing device capable of processing thoughts and text or a pointing or scanning device to select symbols used as part of their communication apparatus.

2.2.5. Diagnosis

In the work with disabled, one activity is always very pertinent for success - a correct assessment of the individual and the needs related to her or his situation. As discussed in an earlier part of this text, the traditional medical diagnostication serves different functions concerning differentiation between disabilities. For educational purposes it was argued that a more holistic approach should be used, stressing strength and opportunities more than disability.

To manage this, you still have to know rather exactly at which level the disabled functions on different criteria, varying from dexterity and fine-motor movements to perceptual speed and accuracy, memory-span and intellectual capacity. For many of these variables we have functional methods, but in some situations the complexity of activity and rapid changes in the individual may prevent accurate measurement.

Take as an example visual discrimination and perceptual ability. It is necessary when new training material for learning disabled are to be prescribed. With the combination of tachistoscope

techniques and a rapid computer, you can easily manipulate crucial variables for performance, be it figure-ground effects, time of presentation or complexity of content. Together with other information, it will constitute part of the total evaluation of the individual.

Another area where computers have been used for diagnostic purposes is in the collecting of information for screening tests, ranging from traditional IQ-tests to performance in behaviour-modification schemes. Here it is used primarily for information processing and storage, but can easily be used when setting up profiles etc.

2.2.6. Training of disabled functions

Not only as a substitute for disabled functions, but also as part of a rehabilitation programme, we can find NICT applied. One of the main problems for people with a severe hearing loss is to learn correct pronunciation - without auditive feedback. People with normal hearing can use what they hear as corrective feedback, enabling them to learn both their own and foreign languages.

Without this ability, very few deaf or hard of hearing can show an oral presentation without giving clear indications of their disability. The communicative value is reduced as well as their self-image.

A very interesting computer application has been developed using a speech recogniser as input device, and calibrated according to certain criteria it can give a variety of visual feedback to speech. With an in-built training programme the disabled is led through stages of complexity, learning to differentiate between pronunciation of the vowels in different combinations, training the intonation of words and sentences and to use his own speech with various volumes.

2.2.7. Information processing

This paragraph applies both to clients and professional people within special education and rehabilitation, but in a slightly different way.

Among people with learning disabilities or other intellectual impairments, the ability to store and use information in a rational way is usually low. Problems about memory is one part of the picture. To pick the right information, at the right moment - and in the best possible combination, that may be beyond the ability for everybody.

To give executives in business and administration a helping hand, decision taking tools are developed for computer usage. Why

should not other people, especially people in need of such help, as a basic rule be given the same opportunities? From our experience with pocket calculators we know they are of very good help during shopping, avoiding to "run out of money" in front of the cashier.
In our efforts to help severely disabled people running their own home and private affairs, as integrated members of society, we can give good examples from the home economics curriculum: How to take care of and use the often inadequate economical resources they have access to, and how to combine a healthy and nutritous diet over time. In both cases equipment like a calculator or small computer running a certain set of programmes can be of help.

The professional personnel may use equipment in approximately the same way, collecting information, storing it and later process it for specific purposes. Statistical information and databases are among the first applications to be used together with text processing. Later also for diagnostic purposes and follow-up studies of clients.

2.2.8. Expressive and creative activities

Persons with reduced abilities to communicate or perform arts due to physical impairments, may use new media to express themselves in writing as well as in music or drawing. The last two examples may need some explanation.

Musicians are today employing equipment like synthesisers to create their masterpieces. With a computer behind, you can compose, edit your composition and play it on a sound generator connected to it (or built into it). If you prefer to work with known melodies, mixing them up with other instruments or rhythms, you just select that on your displayed menu.

If you like to draw, monochrome or colour, you still have the same opportunities as a professional designer with your computer. You choose from the menu - and are in the game. Commercially available equipment (low end priced) give you 64 shades of gray or 260,000 different colours in the palette.

The physically disabled user is not required to employ an instrument or the keyboard to succeed. Use of switches, joysticks or pointing devices (mice) requires control of at least one voluntarily controlled muscle, where the switch can be connected. The more muscles identified as controlled, the more versatile the use will be.

2.2.9. Recreative activities

Just as with the expressive activities, many disabled children are segregated from the playing ground, either because of active

segregation from other children or because their physical impairment make it impossible. The former is more or less a question of attitudes, whereas the latter is conditioned by the usual combination of disability and environmental constrains.

The availability of games, audio- and videotapes cannot compensate for impairments, but a reasonable use of it may in some circumstances reduce the experienced difference between normality and disability.

We all have a need to express ourselves, to be active and creative, and to discover both working life and recreational activities. That is all parts of fundamental human rights and basic social needs.

2.3. New technologies as potential "disabler"

This is a rather controversial formulation, requesting a serious discussion. On the one hand to clarify some of the problems which is always created by new technologies, formulated in this short statement: EVERY TECHNOLOGY HAS A LOSER. On the other hand to intensify our work and mobilise resources to support those who are not among the lucky winners.

To clarify this point, I want to draw upon a Norwegian colleague, professor Edvard Befring:

> When I say that technologies never have been developed for the less able, even as we today can see how technology may help disabled in their everyday activities, I should like to give a few examples.
>
> We can begin already in 1445, when Gutenberg developed his new printing technique. It has been an advantage for most of us, but not the blind. Whereas common people until this time had relied upon oral communication, the blind became increasingly more handicapped as society requested ability to read.
>
> And, when the radio helped the blind, the deaf were unable to take part in common experiences.
>
> Another invention which closed the world for the deaf is the telephone. It is a tragical paradox that Bell tried to develop a sound-amplifier for his hard-of-hearing wife, and in 1875 happened to invent the telephone.
>
> TV and video inhibits the blind, and the use of cars limits their traffic.
>
> That the modern car is the main creator of new handicaps in our society, is another unintended effect of technological development. Traffic injuries are an increasing problem at

> the same time as very few handicapped are able to profit from the potential benefits of a car.
>
> Learning disabled are increasingly being more disabled as the society emphasises understanding and complexity in the use of symbols. In other words, a new technique has negative effects on disabled, because it has been developed on the premises of the fittest.

I have used this citation as a background to the following, just to underline that when we find some situations which are not beneficiary to all potential users, it has nothing to do especially with NICT. It relates to the fact that premises for applying new technologies are never equally distributed in the population. Our main aim should therefore be to minimise potential impairing, thereby maximising the benefits for all, individuals and society.

2.3.1. Ergonomical considerations

In many user environments focus has been more on equipment and methods and less on the total conditions for the disabled. This has created stress and sometimes also severe malfunctioning as regards body posture, viewing angle and keyboard operation. For this reason it must be underlined that close cooperation with other professionals, especially physiotherapists, is necessary to avoid negative effects.

Another point to make is that time spent in front of a display usually should be broken up in intervals. The length of the intervals may be from 15-20 minutes to several hours, depending on tasks performed, personal challenge and motivation, and related to how the actual disability itself interacts with the equipment and creates strain.

2.3.2. Low vision and display-resolution

This is a good example of the above mentioned situation. Display resolution is often defined as the number of pixels or single points which can carry information on the display. Together with other factors like frequency of refreshing the picture and pixel size, it may give a sharp and crisp image or a more blurry impression. Today it should be a minimum requirement to use EGA, or better, VGA graphics to minimise negative effects.

Potential users of eye-glasses (with for example myopia or forie) may also find that the use of blurry displays can give headache and other somatic effects. For them, the use of a computer may work as part of a diagnosis prescribing the use of glasses!

To give even better resolution, many displays may be controlled

by equipment giving even better results than with the VGA. For some users, the choice of a larger display may be of help, whereas others, especially those who are in need of enlarged text, can use equipment with a "magnifying" effect on screen characters. One known instrument can increase character size 3 to 16 times, freely chosen by the user, giving the possibility of full usage of a computer work station for employed people with low vision.

2.3.3. Readability of displayed text

Closely connected with resolution we may also ask how the characters are displayed, the choice of fonts, their form and the use of contrast and colours to give good readability. Besides this, there will also be a transition from reading ordinary pages of text on paper to work with a screen with 25 lines at a maximum of 80 truly readable characters.

These problems can partly be solved by a cautious selection of fonts and colours, combined with displays with good resolution.

2.3.4. Keyboard-complications

Physically disabled people may have problems with the use of keyboards either on a typewriter, a calculator or a computer. This has to do with fine-motor control over hands and fingers, and with the ability to use both hands to control different keys simultaneously.

To overcome some of these problems there are alternative keyboards to allow for individually adapted keywork, keyguards to avoid involuntary pressing of keys, and switch systems to allow for keyboard use through other muscles than those in the hand and fingers. You may even find a "keyboard" which is not existing physically, it only pops up on the screen and can be scanned under the control of one or two keys or switches. In this way a previously complicated and untouchable keyboard emerges as a new world of possibilities for severely impaired users. Paragraph 3.3.2. will also discuss voice-recognition as an alternative to keyboarding.

2.3.5. Level of abstraction in problem-solving and practical operation

New technologies normally requires new skills and knowledge. In addition to this requirement, the knowledge wanted is often belonging to an abstract sphere of information. This can give a strong feeling of impairment and create negative attitudes toward the equipment and methods.

From children's use of computers, we know they are grasping the

fundamental skills very rapidly, even with a diagnosis of mental retardation. The main challenge belongs to the way we are interfacing man to machine - how user friendly we can make the work. Today the use of icons and pointing devices (mouse-applications) has been evaluated as a cost-effective method, reducing the need for training and support to a minimum.

3. A SURVEY OF TECHNOLOGIES AND EQUIPMENT

3.1. Audio-visual media

In education the acronym AV have for long time been a synonym for good presentation techniques and teaching. If we look at the development of communication media during the last decades, we will find that the use of pictures and/or sound have increased their "market share" in education. Outside education, in public and private systems of mass communication, the growth can be described as immense.

3.1.1. Radio and television

We met the first effects of the new media in radio and television. Broadcasting systems, in the beginning based on sound, later on pictures have opened previous barriers between cultures, nations and languages. To a very high degree we share a common base of information, either in a news edition or as pure entertainment.

The availability of reports from the Olympic Games simultaneously all over the world can give us a set of associations: On the one hand as part of a preselected set of information, based upon a totalitarian decision. On the other as the opening for spread of information to simplify distance education, giving every student equal opportunities to learn, regardless of location.

The broadcast perspective has been used in many countries, especially in sparsely populated areas or in subjects where qualified teachers are difficult to find. With the use of satellite transmissions, not only the "Open University" concept can flourish, but also the use in ordinary teaching and even for certain special education tasks.

We are now looking upon this from a <u>teaching</u> perspective. That implies that we are at the sender's side in the process. From a <u>learning</u> perspective we must also take the students activities and reactions into account. The receiver/learner and the interactions between the individual, subject content, way of presentation and teacher reactions may be difficult to handle in pre-formatted media like radio and television, even if ordinary distance education techniques are used.

To give full effect of these media, there will be a need to

avail the learner of a real interactive situation. This can be done in different ways.

3.1.2. Audio-equipment

It is difficult to have real interaction with the radio. You can react to it, but the only effective interaction is with the on/off button. To use it as a real teaching device, not only as an information disseminator, the audio-tape is a good invention, and for several reasons. The main reason is perhaps that it has a standardised format especially as cassette, giving the medium exceptional portability between potential users.

The cassette can be listened to, and you can also record your own reactions, answers and training sessions. It can be played again and again. and you can also return it to your distance teacher for feedback. In this way the student can function in a system of distance education. In the same way the cassette-deck has become a natural element in language teaching within schools, either as a stand-alone activity administered by the teacher, or integrated with textbooks and other training material.

In a special education setting, where the need for repetition may be higher, it can be used for that purpose, and also as motivator for increased performance or persistence.

3.1.3. Film and video-tapes

In just the same manner it is difficult to interact with a film presented on TV. You only react. The distribution of films, either as living pictures or as slides and still photos, has been complicated, due to requirements on equipment. It has been expensive to by the projectors, and their lack of reliability and complexity of operation have been inhibitors to extensive use.

With new techniques and standardised equipment for video-cassettes, it is still not a cheap solution, but it is more reliable than before to present living pictures. With the well-known effects of using AV-media actively in education and training, we have here a new opening, especially when we integrate the computer as element. That will be discussed later in 3.4.7., interactive video.

3.1.4. Electronic mail

New developments in distance education include the use of electronic mail. That is the use of a personal computer connected to a network, dialed through the ordinary telephone system. One possible use in special education is to give the teacher and/or the integrated student the opportunity to access either a database or a message system to get answers on questions.

The teacher may want to ask a resource center on how to handle certain situations. It can be questions about the disability itself, or it can be inquiries for textbooks, teaching material and methodical advice. These techniques are already in use in many situations, and where those who are responding to the questions are not necessarily connected to the resource center, but are colleagues and co-users of the service. In this way there will be sharing of information.

The individual student can in the same way communicate with a "special teacher" at the resource center. In addition the system may be used as the necessary supplement to a broadcast to give the opportunity to have nearly real interaction. The student can here perhaps also get almost immediate feedback on responses to questions etc.

The introduction of electronic mail and audio-visual techniques are NOT intended as a substitute teacher or meant as an alternative to integrative activities. It is a supplement, to be used consciously and the applications must be consistent with the general aims of integration.

3.2. Dedicated communication equipment

To make life easier for people with impaired communication abilities, portable communicators and Braille-systems have been developed. A portable communicator can be described as a device with the capacity to give and/or decode a message.

One of the primary applications is for persons without a spoken language, but who can point to pictures and symbols to create a statement. One example is the use of Bliss-boards, another is pictogrammes. For users with a minimum of fine motor capacity and control of written language, the message can also be keyed in. The more sophisticated versions not only shows the message as a sequence of pictures or words, it is also transmitted as a spoken message through a speech synthesizer or as digitized speech ("recorded" as digital signals). With these versions there may also be the option to choose between male, female and child voice.

Similarly the blind may use a small scanning device to track text on a document or screen and transform it to Braille on a "tactile board" for continuous reading. A similar device can in principle be used for the deaf-blind, giving the interacting person the opportunity to key in a message. In this situation the "non-disabled" person can be seen as the really disabled, because his lack of knowledge of communicating with deaf-blind people!

The preceding paragraphs are not describing tools which are fully computerised, but they may have microtechnology as integrated parts. Their main functions have not been on processing

information, only on transmitting messages, and therefore they have a limited adaptability to individual needs. In the following paragraphs the use of computer-based equipment will be in focus.

3.3. Computer-based input-media

3.3.1. Alternative and expanded keyboards

As previously mentioned, alternative keyboards are necessary to enable users with physical impairments to work with a computer. There are many examples of "keyboard-simulators", either as a touch sensitive board representing as many as 1,000 keys, key-combinations, words or sentences, or as pointing devices like joy-stick, mouse, tracker-ball or switch system, often combined with a scanning system or the use of morse code. On some boards the keys are moved apart, expanded or grouped in a special way to adapt to individual needs and give effective use.

There also exist "virtual" or nonexisting "keyboards", only represented electronically on the screen, and controlled by a single switch. With these systems a user may work with any type of software, be it text-processing, databases or learning programmes.

The possibility of using eye movements and eyegaze can give a valuable short cut to computer usage for severely disabled people. This technique is well suited for a person with very few voluntarily controlled muscles, and where an eye-switch (infra-red or neurologically controlled) is the only way to expression through a communicator.

3.3.2. Voice recognition

Among the dreams of a keyboard-operator is the possibility to use spoken language to command the computer or to deliver information to word-processing systems, databases etc. During the last ten years systems have been continually developed to recognize a spoken vocabulary. From systems with only a handful of phrases, via files covering fewer than hundred words and to a computer with an acceptable reliability in a range of 5000 words.

With a speech recognizer you can drive a car, command a home environment, work in a laboratory or operate a computer system. The availability of this technique opens for a vast range of activities and occupations, increasing both the chances for integration and vocational rehabilitation.

3.3.3. Touch-screens

To reduce the dependency of text and reading, symbol systems and

touch sensitive screens are other alternatives. The user can point directly to that part of the screen which represents the answer to a question or can serve as part of an expression, asking for help or giving input in a conversation.

The use of a touch screen requires well designed software, but it can be less dependent upon abstraction and reading comprehension than ordinary computer systems.

3.4. Computer-based process-oriented systems

In the first part of this paper the capabilities of a computer system to process information was stressed as one of the main assets of the new technologies. The rapid development in this field has opened for a lot of interesting activities. I shall later comment upon some of the different techniques, but first some interesting improvements of the operating systems of personal computers need a remark.

3.4.1. Operating systems and computer architecture

The dominating system of operation in a personal computer has for some years been PC-DOS or MS-DOS. One of the characteristics of DOS is that it could only handle one task at a time, other tasks had to wait for the first one to be finished. Combined with limited ability to handle internal computer memory and with a simple basic architecture restricting the electronic traffic between the different computer devices, the single-tasking DOS worked well with standard applications, whereas more complicated interactive tasks could be experienced as if they were in a "slow-motion".

To give better performance the processing speed has increased from low-end 4.77 Mhz to a high-end 20 Mhz and in more sophisticated processors climbing from Intel 8088 to the 80386. The Intel 80386 processor opens for very interesting applications, but not without a more effective system of operation. The stepwise DOS-applications has to be replaced by truly interactive processes.

In 1987 a new generation of control programmes for personal systems, the OS/2 (Operating System/2), was presented. This announcement came together with the appearance of a new design of computer internals, the MCA or Micro Channel Architecture. Together, OS/2 and MCA has the capability to meet some unfulfilled demands on educational software, especially in situations where the computer must interact with, and more or less has to simulate or adapt to intellectual processes in a human being.

The DOS environment was single-tasking, OS/2 can run, or do, 16 different tasks simultaneously. In a special education setting the main point is that these tasks to some degree can interact

with each other during processing. To be specific, this gives us the opportunity to run one main application (a learning sequence) which is dependent upon the concurrent processing of pictures to be used, the updating of a database covering student performance, which in turn constitutes the base for decisions concerning differentiation, speed of presentation, complexity of exercises etc. in the future progress of the student-computer interaction.

The intricacies of a piece of real educational software, outperforming traditional drill-and-practice exercises, is the fundamental motivator for the use of the new generation of operating systems in special education. The existence of OS/2 and MCA increases total performance of the system, due to the architecture's ability to process and transport information at higher speeds.

In some way the future is here today. It is possible to start working with the new opportunities immediately, but as we know, the development of this new generation of software need some time to grow to maturity. The reasons behind the presentation here are therefore to prepare ourselves to plan for better integrated solutions and explicate our requirements to those who are responsible for the acquisition of software and hardware.

The next paragraphs contain some of the possible elements in a multiprocessing environment. Not as fully integrated in the systems of tomorrow, but as they are functioning in today's DOS-applications.

3.4.2. Knowledge based systems ("artificial intelligence")

Teachers usually behave as an intelligent and emotionally concerned partner to the student, a role which never can be taken over by educational equipment. Nevertheless, we may set up some criteria which technologically based aids has to be measured against to "compete" with the human teacher. Still not as a substitute for the teacher but as a supplement.

Knowledge based systems, often mentioned as KBS, has been through a rapid development the last 10-15 years. Systems of medical diagnosis, tracking of subtraction errors in the teaching and learning of mathematics or auto-pilot services in aviation are examples of this progress. As mentioned earlier, we can today foresee a situation where the student-machine interaction is partly defined by a collection of data, combined within a KBS.

3.4.3. Decision making systems

In short, the KBS is the fundament of a decision making system, either as a "decider" itself, or as a supplier of information to the person asking for it. The decision-maker may here be the end-user, in our setting the disabled child or youth with a need to

compensate for an impaired function, or to maximize efforts where other abilities are the individual's strength.

Examples from educational settings can easily be given, either in the planning of student progress or to make a diagnosis of learning difficulties. In future interactive learning programmes KBS will be seen as a main underlying element.

3.4.4. Word-processors

Word-processing is in this presentation differentiated from language processing, which is a more holistic approach. Working with words requires the writing (or voice input) of text to be organised in sentences, paragraphs, chapters, documents etc, and with an acceptable layout and ortographic standard.

Looking into a catalog of software we immediately can see that word-processing is a well documented activity. In business and administration word-processing is the main activity when computers are concerned, closely followed by financial applications, use of databases and communication.

For many groups of disabled, the usefulness of a word-processer is well documented. Physically impaired users can do occupational tasks never before thought of. A dyslectic child can let the spelling checker pass through a text to avoid the worst orthographic mistakes, store the corrected text and use it later without having to retype or rewrite the same errors again.

In written expressions, students can reorganise a text, move parts of it to new locations to give it a new effect. For students with difficulties in using pencil and paper, the use of a word-processing system is perhaps the best way of taking notes. With a light weight laptop computer connected to braille equipment, a blind student can carry an electronic library and a combined notetaker and typewriter nearly everywhere.

The word-processing system must in the future be seen as part of an integrated work-station capable not only of handling text, but also integrating text with other applications like databases, picture handling, electronic spreadsheets etc. In a process of integration, not only in schools but as well in working life, this development may be seen as the opening of new opportunities.

3.4.5. Language processing

Moving on to language processing we shift from orthographic control to context control, style analysis and automatic translation. These techniques are only in the beginning, but we have already seen some effects concerning automatic translation in international organisations, where the need for documents in many languages are imminent.

A language processor as mentioned may not have the widespread effect on all groups of disabled. We should, however, not forget the new opportunities it can give to overcome some communication problems. For students with learning difficulties, especially if they are working with a foreign language, we also can see that parallel to a spelling checker, a style analyzer may be of good help.

Combined with speech recognition, researchers are now working on systems which could be capable of "understanding" natural language. Surely, the computer cannot be very context sensitive, even if it is able to work within a limited linguistic context and based upon the previously mentioned KBS-techniques. The different connotations or "associative meaning", depending upon social setting etc, are also difficult to handle, whereas the denotations (definitions) of concepts are easier to control.

When, and if, the research materialises in practical results, it should be possible not only to talk to a computer in a predefined manner, it should also be possible to command it in natural language. For controlling electronic equipment in home environments, schools or at work, this may also give some promising outlooks for the future of integration.

3.4.6. Image-processing

Concept formation and language development is a field where use of symbols, pictures and animations are playing a role. The handling of images in a computer requires better processing capacity, speed and memory allocations than word-processing and other standard applications. Especially in situations where slight changes in a picture may be of importance, and where the time lag between two or more presentations should be as short as possible, the use of sophisticated equipment have to be considered. This applies to situations where visual discrimination is of importance or where animation in pictures is essential.

3.4.7. Interactive video

Interactive video represents in some way a parallel to image-processing, but here the pictures are already existing on a storage medium like video-tape or CD-ROM. In practice the tapes are not applicable because of the time needed to search for the right sequences. The product development is in rapid expansion, and linked to a computer, interactive video may be the core of a learning system.

The costs incurred in the planning and production of a master disk for interactive video are high, but in volume production the copies will be much cheaper. Both drives and disks are in

principle similar to CD music equipment, giving an impression of the future of interactive video as a commodity like music discs.

3.5. Output-oriented computer-media

3.5.1. Digitalised and synthetic speech

The "talking computer" can be of good help for communicative purposes or for the blind user. It is not only able to reproduce a few standard sounds or utterances, but also presenting the text in different voices, female or male, child or adult, and with nearly correct articulation. Two methods for computerised speech are mainly used, digitalised and synthetic.

Digitalised speech is recorded. The text or phrases which are to be used, are given as vocal input to the computer for permanent storage. The software picks the right words from the recorded base and integrates them in the total output. The pronunciation can be excellent, depending on the input and the voice amplifier and speaker used.

The alternative, **synthetic speech**, is a text-to-speech system. The computer is supplied with a unit which keeps a set of phonemes linked to single characters or character sequences. When the computer "reads" the text, the characters are checked against the phoneme bank, then triggering the synthesiser. The synthesiser is controlled by software which can instruct on the different voices, pausing and sentence melody. Depending on the richness of the phoneme bank and the synthesiser, this method is the most flexible in use, but usually the digital speech is preferred by the "owner of the voice" because of the "human touch" it can give.

3.5.2. Tactile displays

For a blind user, it is of importance to have a variety of output methods. One is speech, another is the use of a unit which can transform the screen characters to braille symbols. It works as a set of "needles" organised as one or more lines resembling the screen, and in an appropriate number to give the braille-feeling. To represent the screen characters, the needles pop up in the respective braille format. In this way the screen can be read line by line. With additional equipment it is also possible to navigate on the screen to find the information which is needed. When it is found, the blind user can select the appropriate output, either by voice, braille-needles or as "braille-print", embossing dots in thick paper.

A person who has become blind as an adult, must to a very high degree depend upon vocal output from a computer. The ability to develop a good braille-technique is more difficult with increasing age. But some times all blind users need more

information than a voice or braille symbols can give. That is to represent computer graphics and pictures. It is technically possible to let the screen pixels (single points) be represented by pop-up needles, giving the fingers an impression of the picture on the screen, but there are difficulties concerning the reliability of both equipment and the fingers reading the needles. At the moment, cost will restrain development and acquisition of this type of equipment.

3.5.3. Image-magnification

A person with low vision is often able to see enlarged letters, either through magnification or with the use of contrast and colour. A camera can transmit text from a piece of paper onto a TV-screen. Similarly a special device can "catch" the characters on their way from the central processor to the computer-screen and enlarge them for easier reading. With a pointing device like a mouse, the user can select the interesting part of the screen and deliberately choose the degree of magnification in the range 3-16.

Good examples exists concerning the integration of both students and employees into ordinary school and work situations with the help of this device.

4. POTENTIAL EFFECTS AMONG USERS

4.1. The impact of "The new technological society"

Every society interacts with its members and have a certain set of impacts upon each individual. If we take into account different characteristics of what could be called a "new technological society", we should find that it may differ from how societies based upon other technologies functions.

One of the effects is that **interpersonal communication and social relations** in some ways have changed. Radio and TV has created new social habits, giving a broad offering of information and entertainment to all, and in the home, but it has also reduced some of the previous social contacts. This consequence is partly a necessity since time consumed in front of a TV-set very seldom can be used for other purposes. The negative effect of this is that the social network can be more transparent, placing disabled at stake, and isolate more than integrate people. Steps has to be taken to minimize these negative outcomes.

Concerning **language acquisition** it seems to be more dominated by media and "international" culture as children are looking at TV-productions prepared for an international public. A consequence of this is that their own "roots" to some degree may suffer, creating some sort of bi- or multicultural children. For most children this is easily handled, but for those who on beforehand

have difficulties in the acquisition of language, their performance at school will suffer. The effects of computer assisted teaching and learning is not well documented here.

A parallel to language acquisition is their **verbal expression**. Children's play activities is heavily dominated by what they learn from new media. Depending upon what they have access to, the outcome may be both positive and negative. But, if children are only a consumer of media, with limited experiences in play, verbal stimulation and expression, the impact of the new technologies may as well function as an impairing condition.

Children's **creativity** is perhaps their main asset as they are trying to conquer a new world. The adult society may easily inhibit their creativity in presenting solutions, curbing activity or predefine techniques. Teaching practice can have doubtful effects here, easily prolonged with certain types of drill-and-practice software when using a computer for learning purposes. The need for well designed approaches to learning with new media must be underlined. What has been said on previous occasions shall not be repeated, but it is necessary to study the possibilities which is presented with new generations of equipment.

Creativity is a prerequisite to **problem-solving abilities**. Studies on the use of computers in education indicate that certain types of software and activities have a positive effect on creativity and problem-solving. Generally it seems to be more positive to use open-ended software and activities which leave the student with the initiative. This is the case in some educational games and systems like LOGO. On the contrary, some traditional software based upon predefined answers and with little flexibility have been found to give negative effects on student performance.

An interesting hypothesis here is **metacognition**, the students ability to trace his own reasoning and evaluate methods and outcomes. As with creativity and problem-solving abilities, certain activities seem to be more suitable to increase student performance. The conclusions, however, does not show that the students are more "intelligent" after having used LOGO or open-ended computer software, but their own intellectual resources are applied in a more efficient way.

The **emotional development** and **self-esteem** of children is often underestimated when educational approaches are concerned. If we look at some of the recently created opportunities for disabled children in utilizing new technologies, all indications should be toward better educational performance, followed by a more stable emotional condition and better self-esteem. Even if their performance still could be increased by new methods or equipment, their relative position is better than before.

We should here also take into the account that as new

technologies in education are progressing, students are generally provided with better solutions. What is known and used today, may not be the best tomorrow. In that perspective we should also expect frustrations caused by the mere existence of even better products than is now supplied. Without financial support the opportunities may be more of a "fata morgana" than plain reality.

4.2. Technology for equity and autonomy

The question of equity for all members of society has been on the agenda for social reforms in most countries. To be more precise, it can be defined as a question of giving all people **equal** rights, the meaning of which is to express the formal right to take part in all activities in a society. From practice it can easily be shown that this formality is not enough to meet some simple criteria of fairness, even if the disabled are formally defined as qualified for receiving support, equipment and training.

A right is not the same as reality. Therefore it is necessary to secure all members **equal opportunities**. That should mean that every qualified can have a real chance to avail herself of the defined resources. It should include different variables like motivation, financial support, time, positive attitudes etc.

The authenticity of the idea of equity can only be proven when we look at how members of a society are valued. If disabled people are not given the **equal worth** as citizens, rated as a full member of society, the question of equity still has to be answered. Within the framework of this document, it is relevant to ask to what extent new technologies can be of help.

Sex equity has been in focus for some time concerning other aspects of social life, working conditions and education. The question is relevant also when actions for disabled people are taken. If existing trends should be the same as in other areas, we can immediately foresee that boys are getting better opportunities than girls. As part of an elementary Human Rights programme to provide equal opportunities for all disabled, it will be a step backward if sex equity is not included.

Another perspective on equity is to what extent the disabled acquires autonomy in his or her personal life. Autonomy in its different appearances is one of the main criteria for full membership in society. To be integrated means to be transferred from a segregated or isolated position to an ordinary environment, with the rights and obligations that is linked to it. **To be able to use the rights and fulfill the obligations is perhaps the final test for equity, autonomy and integration.**

4.3. Technological compensation of disability

Physically impaired persons must depend upon technical aids or on a restructuring of their living environment to overcome barriers as stairs, prosthesis control etc. This is only part of the problem. It is far more interesting to ask how it influences the psychological idea about oneself.

For many disabled the employment of the new technologies to master daily life situations, their work or leisure activities can give rise to a new or broadened concept of self. Determined by type of disability, selection of equipment and how it is implemented, the end-user may experience various effects. Both **physically, intellectually and emotionally** the compensatory actions have feedback effects on self-esteem.

4.4. Rehabilitation

For some disabled the concept "rehabilitation" is used. We seldom have to rehabilitate school children, but disabled adults are often in a position where they have potentials for full or part-time employment. For them certain types of rehabilitation can be achieved through adult education and training. This applies especially to people who have to accomodate to an acquired impairment, but who can perform their profession. To learn the full advantages of NIT equipment, it is usually necessary to sign up for a course.

Other groups of disabled have to go through vocational education and retraining to meet requirements in an adapted job. This is the normal situation, because very often neither the available equipment nor the job conditions in the former profession can be harmonised with the actual impairment.

A special group concerns the rehabilitation of war handicapped. The real-life conditions for soldiers and civilians in some regions are still war or war-like. This creates a continuous flow of new cases, partly soldiers and to an increasing degree children with war injuries. To meet their needs should be a Priority One activity until the world-wide cease-fire can be achieved.

4.5. Leisure and recreation

The effects upon leisure and recreation should not be underestimated. By using computer games, music activities, design and drawing, verbal expression and physical activities, all through the help of NIT, disabled children can be given the same opportunities for recreative experiences as ordinary children. Besides the leisure activities, there will also be a learning element in it.

An example of that is a theory of child development, stating that to learn concepts of form, location or room, you must also have the chance to manipulate objects, move to and from, into and out. If the theory is correct, NIT based equipment may be the sole way to give severely disabled children the necessary availability of learning experiences.

5. REQUIREMENTS

The task of integrating disabled students within an ordinary educational institution may be an uncertain process and with unknown results if some basic requirements are not satisfied. In the following some of these conditions will be discussed. The significance of each of them will be stressed, and in the planning of an educational reform covering integration none of them should be left behind.

5.1. Information collection and dissemination to draw upon a common base of experience

To improve the value of available resources within an educational system, it is of primary importance to set up a service capable to cover an existing base of experience. From educational practice there will always be knowledge about methods, material etc. residing in schools, among colleagues or in libraries and collections. To avail potential users of this base of information a system or network has to be created, giving access to other people's experiences.

The information collection can be part of a **local service** covering a few schools or institutions. Such an educational cooperative may be a very good fundament for exchange of experiences and innovation. To be more comprehensive, it should, however, be organised at **national level**, and be linked to a **cross-national or cross-cultural service**. At least there should be a possibility to retrieve information from systems outside the close surroundings to get input and ideas for rethinking educational practice.

The main aim of an information system of this type is to get an overview of existing educational material, equipment or hardware, teaching methods and software. To increase teachers' knowledge about this, is one of the least expensive ways of resource investments in schools.

A related base of information could also be covering the support institutions and agencies where help and guidance can be found. Closely linked to this is a database covering resource persons and experts available for use in schools.

5.2. Adapted educational and social infrastructure

Disability is the degree of match or mismatch as regards our living environment. The parallel question for integration is the degree of correspondence between the disabled's needs and the ability of the educational environment to adapt to these needs. Often we can find very traditional and inflexible attitudes toward the disabled. Rigid systems must be softened to have the necessary openness to innovation, and barriers against change have to be passed via shortcuts or through structural changes. Some of the actual fields of study will be reported here.

5.2.1. An integrating educational system

As previously mentioned, the openness of the educational system toward disabled is one of the main supporting factors. Some schools and institutions are by definition nearly segregating, either through a pedagogical perspective or because of architectural and organisational decisions. A few examples:

Schools with a strict elitist perspective have seldom room for students requiring special attendance or with learning abilities which may lower the final results of the school. By tradition these groups of students are sent to special schools (at best) or left outside the educational system.

To many physically disabled, the mere presence of stairs is prohibitive to participation. The blind may need mobility aids, and communication equipment is necessary for students without a spoken language. Transportation to and from school is also a question. Physical disability is even more disabling in such an environment.

In some countries the differentiation between "normal" schools and "special" schools is very strict. In the discussions of how the educational system should be organised, the traditional boundaries are kept, often because fundamental knowledge of existing material, media and equipment is lacking. As mentioned in preceding chapters, it is today possible to overcome many barriers which in earlier times should have placed the disabled in a segregated position forever.

A few words about "special" schools should be mentioned here. Established institutions for certain groups of disabled are in many countries about to be left unoccupied because of change in attitudes and a very high degree of integration. This immediately creates a new situation: How should the experience and expertise in these institutions be taken care of? If qualified personnel are redeployed throughout the educational system, a scattering effect is the result. The experts are spread, but their common base of knowledge is destroyed. To the total educational system it may be a disaster when the invested resources are evaluated.

The next paragraphs will discuss alternative redeployment of experts.

5.2.2. Diagnostication and counselling services

In the analysis of disability the individual's potential for coping with a disabling environment was stressed. The following "main roads" were mentioned:

a) - to concentrate on the impairment as such, according to a diagnosis, using remedial methods like corrective surgery and medication, therapeutic techniques and training or use of prosthesises.

b) - to compensate for the impaired function by supporting other functions, either by training or by using adaptive equipment and technical aids.

c) - to "redefine" the environment and task requirements in such a way that the previously impaired functions no longer are required, or that the relative impairment no longer exists or has been reduced (e.g. stairs and wheel-chairs).

To undertake these tasks we need qualified personnel capable of giving a correct diagnosis, followed by guidelines for further actions from teachers, parents or the individual concerned. When a database covering resource personnel was discussed, the professionals needed here should be among the first to be included.

From practice we know that early diagnosis of disability give us an advance in our efforts to minimize the negative effects through proper treatment. Further treatment and training implies the same use of qualified personnel, but under most circumstances this can be done in cooperation with the teaching staff in ordinary schools after the necessary preparatory training of them has taken place.

5.2.3. Family services and interest organisations for the disabled and their relatives

When a disabled child is born into a family, it often happens that the relatives react in a negative way. The family is in need of support and guidance to meet the new conditions. There is good experience with interest organisations for parents and later also for the disabled themselves.

These organisations should be organised on a national basis and with local groups. The local groups can support members more directly than a national organisation, but in cases where political activity or international cooperation is appropriate, a national umbrella organisation can fulfill such a task.

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5.2.4. Availability of information within an existing welfare service

Nothing can be done without access to information on "why and how" to handle certain cases. This applies not only to questions about methods and materials, but as well to social security problems, financial help, contact with parents' associations etc.

From a practical point of view, an information service should be an integrated part of a social welfare system. It could be organised nationally and operated locally, either as a computer based system as we will see in future solutions, or as a more traditional "person and paper" function.

An information bank has to be updated regularly and it must give relevant information for the user. In this setting it should mean that material no longer available, schools which are reorganised or shut down. financial support no longer valid or not updated with the latest regulations, should carefully be removed from the information system. Nothing is more frustrating than getting information which later shows up as empty.

5.2.5. Established routines for the transition from school to active working life

To cover the need for help when school is finished, the disabled more than other groups depend upon support routines for the transition into active working life. Within the social security system, resources should be available to help this change which can be seen as the final proof of how effective or successful integration has been.

The routines should cover aspects as sheltered workshops, rehabilitation/retraining activities, financial support to employers to soften the transition etc. In addition the service should also be staffed with qualified personnel to make the activity prosperous.

5.3. Availability of suitable hardware and software

To act satisfactorily in a situation were new methods and media have to be carefully selected, you always have to rely upon available information. But even if you act according to the given information, you are in reality getting a severe setback if the chosen software and equipment are unavailable. The stumbling block is as much of psychological as of practical nature, but the backfire effects may still be important.

5.3.1. Planning, design and development of software

To activate the potential of NIT equipment the user have to rely upon an adequate set of software. Experience from development work can clearly tell that good software is more than plain programming of a computer.

The software should meet the expressed needs, it should have a consistent design, both structurally, on screen and concerning the interfacing of additional equipment, and it should be developed according to plans and criteria. These requirements are necessary to enforce compatibility between systems, which in turn can allow users with additional equipment to communicate. In addition, the documentation, manuals and reference sheets should be well elaborated and adapted to the user's needs, not the programmer's!

5.3.2. Compatibility of equipment - portability of software

The concept "compatibility" is often misused. Among vendors of hardware and software it is often given as a measure, countable in percent, "expressing" that the materiel can do the same as other equipment. Reality is that compatibility can be described as a "yes-or-no" question. The user must in every case be well aware that incompatibility may be found, and that an extensive testing of equipment with the relevant software is the only way to safeguard against it. Examples of incompatibility can easily be found in communication between computers (network specifications), in screen handling or in the interaction between hardware and software, including operating systems.

A standard of design can be defined as a certain way to organise the program itself, how it is structured. What are the routines within the program, how are they linked, and how can they eventually be merged with other software.

Another aspect of design is the screen lay-out and the definition of specialised keys on the keyboard. Where do we find the important information, in what field should the response or user input be given, where are the help- or hot-key to get further assistance from the teacher or the system, and what are the routines to enter and exit the application? The software designers should be very careful to follow accepted standards to be consistent with other applications. Users who are comfortable with an established standard like SAA (Systems Application Architecture), can easily find their way through other SAA designed software, because the "modus operandi" of the programs are very like.

In special education and rehabilitation the question of interfacing additional components with the base system may be the very crucial one. How should a speech synthesiser be linked to the computer? What ports are necessary, and how are the signals

transmitted? In these cases compatibility between systems have to be 100%, unless you have an "omni-potent" service-engineer available to resolder equipment or reprogram software.

The operating system is the internal "traffic police" of the computer. With different operating systems you are in the same situation as a policeman trying to organise right- and left-hand traffic on the same road. Software designed under different operating systems have to be rewritten to avoid traffic jams and chaos in the computer.

The dominating operating system for microcomputers or personal computers have been PC-DOS/MS-DOS throughout the '80-ties, leaving CP/M behind, but with a "symbiotic" relationship with the next generation of operating systems, the OS/2. Software written under DOS may usually run in the DOS compatibility box of OS/2, securing user investments in software, but requiring an upgrade of processor capacity from Intel 8088/8086 to Intel 80286 or 80386, and with 80486 lurking in the shades.

In principle it can be said that software written under DOS in 1981 (depending upon programmer and consistency of standards) will run on new generations of equipment in 1991, either as a pure DOS application or in the compatibility box of OS/2. If the software is "well-behaved", without too many of the programmer's private tricks, functional standards for design and operating systems can simplify portability of software and the preferred exchange of experiences.

5.3.3. Organised service to secure availability of hardware, software and support from vendors

The new information and communication technologies not only resembles the quantum leap in physics, it may also be seen as a picture of the turbulence and rapid shifts in cosmos. Producers, vendors and remarketers are popping up - and often disappear before their product have penetrated the market. For the customer it may be a disaster, economically and functionally, to be left behind with obsolete equipment and zero support.

At national and/or regional level it should therefore be issued guidelines for contractors on equipment, together with routines to check the solidity of vendors. Equipment acquired today should last for several years, and availability of future support and service is a minimum condition before signing the contract.

5.3.4. A "try and buy"-service for testing of equipment with the actual user

Together with the long-time perspective of future support and service, the need for an adequate diagnosis of the user and a test of the equipment in a real situation is a prerequisite. A

central institution, at national or regional level, should have the competence and base of equipment to run a "try and/or buy" service to meet individual needs.

In some countries a center has been set up at regional or county level, serving a range of purposes, from diagnosis and guidance to evaluation of functionality of equipment. Specialised institutions may for their clients run a similar activity, being both a competence center for the nation and a resource and support center for defined groups of clients.

5.4. Resource allocation and administration

Resources, either financially or functionally, are always a constraint on development. The field of special education and rehabilitation is not a deviation from this common knowledge. We should for that reason be conscious about how, where, and for whom available resources are used.

The first step in a planning process is therefore to describe the actual condition with the individual's implicit and explicit needs, together with a rough overview of barriers or limitations which have to be overcome. If possible, available resources should also be identified.

5.4.1. Cost analysis and budgetting

Having described the different needs, together with the preferred or necessary actions, a detailed elaboration of costs is required. It is here of importance to note that the process must be seen in both a short and a long range perspective. Very often the follow-up activities are forgotten, resulting in a total or near total loss of effect over time.

The intention of integration is not to place a person in a new situation - with new equipment, and without the necessary services to continue educational and personal development. Examples here are students with a computer capable of doing a broad range of activities, left with an introductory course to the system, but with little or no software to "grow" with.

Budgets are required for several reasons. To compare benefits and costs, to get an overview of the total expenses or to have the indispensable documentation when funding agencies are asking whether the action is well planned.

5.4.2. Resource allocation and administration

As mentioned, resources are not constrained to financial support. Personnel, available equipment and methods are also examples. The task of tracking and organising the resources should not be

underestimated.

The next step then is to distribute them in a professional and economical sound manner, to maximize the intended benefits for the person involved, and also take both future use and alternative development into account.

A register of available resources has been mentioned as a prerequisite for successful integration. This applies particularly to the administration of resources, both directly in a situation at school, and as a function which have to be run independently of the single student.

5.4.3. Follow-up services to secure adequate use of resources according to intended effect for the disabled

Besides administrative functions, professional support must be available. This means that personnel at the school should have the opportunity to qualify for their new role, to get necessary skill with new equipment and to receive help and hints from the staff at resource centers.

A supplementary "investment" is to organise meetings or seminars were teachers from different schools, but with similar work situations, can discuss and exchange their experiences. This is often seen as part of an in-service training of teachers.

5.5. Integration on the disabled's terms

5.5.1. Physical conditions

Needless to say, architectural considerations must be made to give physically disabled people access to buildings, lifts, libraries, toilets, transportation facilities etc. This is the very first condition to be met for one group of disabled. But physical conditions is a broader concept.

With severe hearing loss it is a necessity to have a reduced noice level in the surroundings to profit from hearing aids. A user of computer equipment, bound to a wheel-chair or bed, must have the keyboard or switch-sets arranged in a way which is suitable to good body posture or well within reach of voluntarily controlled muscles. The visually disabled should only work with displays of excellent graphical standard.

These examples are only a few - every disabled user should have the work-station individually designed and tested to be confident with it. As previously stated, this could be one part of the systematic follow-up service which should be organised around the integrated student.

5.5.2. Social organisation

We all need backing and support from friends, relatives or parents. For the disabled and their families it is of crucial importance to have a social network behind. In a situation where integration into an existing group creates new challenges, the help from a well known group of people may be the fundament of success.

The young disabled is also in need of contact with other youngsters. This is a psychological fact which could be taken care of by school staff. To establish good social relations with other students helps both learning and personal development of all students.

But in addition to contact at school, disabled children may profit from the exchange of experiences with other adolescents in a corresponding situation. This could be done through social activities during the school year, and possibly as holiday camps or meetings.

5.5.3. Development plans suitable for integration

To avoid situations where buildings, installations, furniture and equipment have to be rebuilt or adapted to meet fundamental needs before integration can take place, planning of schools should include integration as part of the ordinary school life.

The new information and communication technologies as applied for disabled can often be seen as spin-offs from space-technology or military research. Education and rehabilitation have to wait until someone is clever enough to transfer knowledge and technology to the disabled. Parallel to the planning of buildings, the research and development of micro-technology should bear in mind and be directed toward the needs of disabled people.

This has to do with attitudes and awareness, and should be under the responsibility of every planner.

5.5.4. Curricula and examinations

Integration is to give room for individuality - within established settings. Concerning the curriculum, there should be given room for modifications. It is impossible for a person without muscular control to perform **handwriting**, but through a switch-set it is possible to do **writing**. There should be no doubt about the permission to make such deviations from an established curriculum.

When examinations are to be met, the tradition has been to claim equal treatment, in every aspect of educational achievement. If

disabled students are to be treated on an equal basis with their peers, the have to be treated unequally. A student using an alternative keyboard must be given more time to do the input, and it has to be accepted that when you are using a word-processing system with a computer, you may also profit from tools built into the system. In some way this is how a dyslectic student can compete, not on equal terms with his peers, but more equal than before.

5.5.5. Cross-disciplinary professional teams

Integration is a multi-faceted approach. To take full care of the task, the responsible staff should also be multi-faceted - or be set up with competence from various disciplines. The fruitfulness of a cross-disciplinary approach should not be under-estimated.

5.6. Attitude changes

In every situation where roles are changed, attitudes and prejudices are engaged - among all participants. It is therefore essential to a successful integration to prepare all partakers. This means that the disabled and their families, neighbours and people in the local communities, the different groups of professionals involved, together with "normally" functioning pupils, they should all pass through a program preparing them for what is often a totally new experience.

5.7. Ethical considerations

When an integrative approach is carefully thought about, the ethical aspect of the decision should not be forgotten. Usually it is said that integration is "good", based upon principles of equity, keeping the child in its own environment or even for economical reasons.

Not all reasons behind are acceptable, at least not for the person involved if the "normals" decide on their own terms and conditions, and without taking the individual's personal needs, hopes and ambitions into account. Usually new equipment, methods and materials are working together, giving a richer life. Sometimes, however, integration may mean moving the child in need away from necessary professional services or into an environment which is incompatible with the child's own resources.

It has been said that nothing is more unequal than equal handling of unequals. If we, as integrators, are being deceived by information and communication technology without a critical consideration of the dazzling effects of the new, we may run the hazard of segregating <u>within</u> an integrative approach.

Then we have got children at risk.

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6. TEACHER EDUCATION/TRAINING OF PROFESSIONALS

6.1. Awareness to see possibilities - not disabilities

One of the main aims for the training of teachers and other specialists is to place their professional skills in an integrative perspective. As mentioned in the first chapter of this document, the change in the perception of disableds' potentials has underlined a need for understanding how the different possibilities can be enabled - instead of disabled.

Within an established educational system, often described as very rigid and inflexible, it is therefore necessary to give all participants information and motivation to change existing structures to prepare a profitable result for all involved.

Moving a little further, this should also mean that innovative activities may be a good investment in changing educational practice. To arrange seminars and workshops where professional personnel can exchange their experiences could be a first step. In addition, more systematic approaches aimed at the training of teachers, medical and paramedical personnel as well as decision makers must be planned.

6.2. General teacher training

Teacher training is organised in quite different ways, depending upon national requirements, educational tradition and school level. In principle a teacher can have a basic training, giving a broad competence and preparing for employment in general education. The usual alternative is a strict subject oriented teacher education, giving a "specialist" training in a few subjects.

The first alternative ends up with the generalist, prepared to cover a broad range of subjects. In practice they possibly also have to cover special education, even if these aspects of basic training only to a small extent have been taken note of.

The second alternative very seldom can be found to be oriented toward special education, and teachers with a strict subject oriented background may be less motivated to include a special education or integrative approach in their teaching.

One advice, practiced in some countries, is to include in every teacher's basic training a certain element of special education. In Norwegian teacher training every student intending to teach in primary school must as a minimum complete a half-year course of special education aimed at the integration of most groups of disabled. Teachers preparing for their certification within a university structure, must in addition to their subject-oriented

examinations pass through a special education course, and can even take a block of a half-year or more as part of their final documentation. Through this option also secondary schools may be furnished with teachers having a certain degree of special education knowledge.

In this way every student now leaving a college or university to start teaching have a minimum of competence in special education. But the eternal question is - what about those who already are inside the system?

6.3. In-service training

The most used method to meet the demand for new skills and knowledge within an existing staff, is to arrange for in-service training. This could be organised in different ways. Evening or weekend courses could be used, or seminars could be organised in connection with school holidays or as workshops where groups of teachers could meet and learn from each other. A supplement to this would be the centrally organised counselling services.

In-service training could focus upon the integration of groups of disabled, on the use of new equipment and methods, or to study new applications or software available. To meet the needs of continuous development of practice, it should also be considered to set up small projects locally where acquired skills and knowledge could be put to a test in real educational settings. The positive effects of teamwork and cross-disciplinary contact should never be underestimated.

A problem which may arise is that in-service training often interferes with the regulation of working conditions. The financial side of this is a very costly one. To pay for replacement teachers may take too much of available resources, and it could be a good advice to avoid doing this in ordinary school time. Instead of paying for replacement teachers, it could be a better investment to give teachers a bonus, not necessarily a sum of money, perhaps better as a scholarship or travel grant when they had attained a certain skill level. This should be linked to in-service training or in combination with a system of formalised further education.

6.4. Further education

To meet the need for both a broader perspective and higher level of competence, a system of organised further education of teachers should be set up. I once again return to my Norwegian experience where the efforts to introduce the new technologies in both special education and teacher training have been focused.

Teachers can, in addition to their basic training, opt for a half-year of training in informatics followed by a half-year of

applied informatics related to special education. Those who are particularly motivated may proceed with from one to three years of specialisation, giving a masters degree. A few have even proceeded within a doctoral programme to meet the requirements for a formal qualification as researcher in the field of NIT applications in special education.

This may not be a suitable approach in all countries, but depending on local circumstances, further education will be one way of developing a highly specialised corps of teachers. As already mentioned, this group may be the backbone of counselling services, develcpment work or as members of teams with planning and administrative tasks.

6.5. Physiotherapists and ergotherapists, medical and paramedical personnel

The value of cross-disciplinary teams has been mentioned on several occasions. It should therefore be provided for contact between these groups and teachers, giving all the right educational perspective and motivate the integration of disabled.

To accomplish this, the teaching staff should know a little more about these specialists' skills and potential help. On the contrary, the physiotherapist should know more about school and the student's challenges as well as relevant educational applications of NIT. It seems also to be necessary for them to have a basic knowledge, not only of existing applications but more of the potential use of technology. This is a prerequisite to be creative in the use of new equipment adapted to individual students' needs.

In some way the technicians working with adaptive equipment are in need of training and upgrading, just to be able to see the encouraging perspectives. Together with educational and medical staff they are the key to efficient use of NIT.

6.6. Information to administrators and policy makers

Administrators and policy makers are seldom in direct contact with the clients, but their decisions may have severe effects on them. Lack of knowledge is a threat to prosperity and reasonable use of resources. These significant groups should therefore be introduced to the underlying technology and experience some of the success stories.

Formal training is not the way to go, but participation in some workshops together with cross-disciplinary contacts could be a solution. The main aim of these information activities is to present integration as part of their educational policy-making and to show some routes to follow.

The educational planner should also profit from insight into innovative strategies and techniques, just to be prepared for the necessary changes in structure, content and methods which have to be applied with new information and communication technologies.

6.7. Research and development workers

The educational planner and policy maker will always ask for reasons for taking certain steps. This is also the case when decision makers are going to allocate funds for new equipment or unknown methods.

We therefore need the help of professional researchers to undertake evaluation studies of activities. And we need the cooperation of development workers to pick equipment from the market, adapt it to the actual conditions and combine it with the right methods to release the inherent potential of technology.

They should, in line with the planners, be well aware of innovation methods, and to a higher degree know the underlying technology and especially the marketplace for applications and equipment. Their role as partner in local development projects should also be stressed here. For that reason their knowledge of social structures, especially in an inflexible educational setting, is of crucial importance to a prospective development.

7.CONCLUSION

A recapitulation of the preceding chapters tell us that the last twenty years have brought about a tremendous shift in both the attitudes toward disabled learners in school and the availability of new information and communication technologies in general.

The main challenge' today has been documented as the selection and use of these new technologies in special education and rehabilitation, as a help and not a hindrance to disabled users. Examples have been presented showing the potential of the new equipment, together with series of "proofs" of how they may be applied for integrative purposes.

A set of prerequisites for a successful use has also been presented, and where the need for information, educational and social infrastructure, resource allocation, and training of teachers and other groups of professionals was stressed.

A certain aspect of the use of the new technologies was discussed as an ethical perspective. On the one hand that the disabled should take part in the discussion to secure that the decisions taken were not contrary to his or her most profound interest. On the other to keep in mind a perspective of equity, a perspective which should also take into account the possibilities of the new technologies for groups not usually associated with "physical

handicaps". In some way, these groups with learning disabilities may be the most prospective when we look into the future. At the same time they are threatened by new technological leaps forward, creating a "backslide" situation where their relative movement could be in the wrong direction.

It may be said that the new information and communication technologies is a rising sun for many groups of disabled. We need, however, the necessary attitudes, methods and media to make the integrative educational system prosper having all students to benefit both from each other and the technology.

The challenge is here - and we are going to take it!